DRINKING WATER QUALITY ASSESSMENT AMONG RURAL AREAS SUPPLIED BY A CENTRALIZED WATER SYSTEM IN *BRASOV* COUNTY

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This paper aims to evaluate the quality of the drinking water sources from rural areas in order to protect public health. A total of 197 drinking water sources from rural localities in Brasov country were evaluated according to microbiological and physical-chemical parameters. The greatest danger to individuals is represented by the ingestion of animal or human feces contaminated water. The analysis of drinkable water samples from the current study has shown a series of causes which may have led to the lack of fulfillment of the drinkability parameters.

Keywords: drinking water, quality, rural areas, public health

1. Introduction

Drinking water (or potable water) is clean water, which can be consumed by humans or animals alike, without any risks of harm. Water is essential to the survival of most living organisms, whether they drink it or absorb it. For humans, water is extremely important, the total body water is about 60 per cent of the body weigh [1,2].

We need water in our daily life for drinking and food preparation, thus water needs to be of high quality, safe and sufficient. There are, of course, other uses for water, such as washing, cleaning, hygiene, or watering plants [3].

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The European Union has been monitoring drinking water for over 30 years, and the laws regarding the regulations to be followed for water to be fit for human consumption are very strict. The main pillars of E.U. policy regarding water and health protection are to:

- ensure potable water quality is rigorously controlled through standards sustained by the latest scientific evidence;
- secure an effective and efficient monitoring, assessment and enforcement of the quality of potable water;
- provide adequate, timely and appropriate information to consumers regarding their drinking water;
- Contribute to the broader E.U. water and health policy.

In the European Union, drinking water is standardized through the 98/83/CE Directive regarding the quality of the water destined for human consumption. In Romania potable water is defined and standardized through the law regarding the quality of drinking water from 2002, completed and modified on the 28th of June, 2004[4].

Contaminated water (either chemically, or microbiologically) have caused a multitude of adverse health effects, especially among susceptible individuals such as children, elderly persons or immunocompromised patients. Thus it is of highest priority to ensure that adequate measures are being taken to further investigate and decontaminate water sources which produce non-compliantsamples in order to provide both urban and rural population with safe drinking water [5,6].

According to the laws in force, our country ensures that drinking water:

- does not contain a concentration of microorganisms, parasites or any other substances which could endanger human health;
- complies with the minimum requirements (microbiological, chemical and radioactivity parameters) established by the aforementioned Directive.

E.U. states establish parameter values that must correspond at least to the values established by the Directive. The monitoring of drinking water quality covers all the localities in Romania, but the number of analyzed parameters is very limited in many localities.

The purpose of control monitoring is to periodically bring information about the organoleptic and microbiological quality of produced and distributed drinking water. Also, the monitoring informs about the efficiency of treatment technologies, particularly about disinfection, with the purpose of determining whether the potable water corresponds or not to the established parameters. Some of the drinking water quality monitoring tasks and infection risks analyze and estimation can be done using computational methods [7,8,9].

According to the statistics of the Ministry of Health, performed during the annual authorization of treatment stations, the following results were obtained:

- 2% of the public water systems that provide for more than 50 people and less than 5,000 have water inadequate to bacteriological, turbidity, ammonium, nitrites and iron parameters;
- monitoring the quality of potable water by the producers from the rural area, in localities with less than 5,000 inhabitants takes place only for chemical parameters in 5% of treatment stations.

Access to safe drinking water has been a central aim of public health and international development policy for a long time.

The purpose of this paper is the evaluation of the quality of the sources of drinking water from rural areas in order to protect public health through:

a) preventing illnesses associated to drinking water supplied in rural areas;

b) identifying the unconformity situations of analyzed physical-chemical and microbiological parameters;

c) evaluation of the health risksfor the supplied population.

The target population is that of rural areas supplied with drinking water in centralized system.

2. Metodology

Water samples have been taken and analysed according to SRENISO 5667-2:2004 and SRENISO 19458:2007 standards. The Diagnostics and Public Health Investigation Laboratory has the accreditation certificate number: LI 1024-RENAR, valid from 08.05.2014 until 07.05.2018.

For microbiological analyses the membrane filtration method is used in order to detect and count colonies of *E. Coli*, *coliform* bacteria and intestinal enterococci. The mediums used are: Yeast, Cromogen CCA, Slanetz, Batanay ABE.

For physio-chemical analyses methods of chromatography are used in the gaseous phase for trihalomethanes (THMs) - AUTOSYSTEM XL apparatus.

Also, determination of atomic absorption through spectrometry is used with flame atomization for Sodium or in a graphite oven for Pb, Cu, Cd, Cr, Mn, Fe.

Determination of free and total residual chlorine, ammonium content and nitrates is accomplished through UV-VIS 750 I methods.

Determination of pH and conductivity is accomplished through electrochemical methods and turbidity determination through nephelometric methods.

Contaminated drinking water may contain pathogens that cause major infectious diseases such as cholera and other diarrheal diseases, dysenteries, and enteric fevers [6,10,11]. These are not only a major burden on public health, but from among them diarrhea is also a leading cause in infant and child deaths, especially in areas with low-income households [12].

The effects of exposure to pathogens may vary from one individual to another, or from one population to another, as repeated exposure to a certain pathogen may increase the immunity of the exposed population, thus decrease the severity of possible illnesses. There are several infections whose severity may vary: the waterborne infection by E. coli O157 and other entero-hemorrhagic strains of E. coli are less common than infection by Campylobacter bacteria but their symptoms are more severe, including the hemolytic uremic syndrome and eventually death.

The prevalence of immunity of individuals leads to the fact that not all infected individuals will develop symptomatic diseases, thus a certain percent of the infected population (including carriers) is asymptomatic. Those with asymptomatic infections, as well as patients during and after illness, may contribute to a secondary spread of pathogens which are now transmitted not only through *E. coli* contaminated drinking water [11].

Indeed, feces from cattle, swine, poultry, wildlife, and pets are thought to be important vectors of waterborne pathogens like *Escherichia coli* O157:H7, *Campylobacter jejuni*, *Campylobacter coli* or *Giardia duodenalis*. Thus, enhanced surveillance of the water sources tested in our study is of utmost importance in order to prevent potential waterborne-disease outbreaks.

3. Results and discussions

There have been evaluated 197 drinking water sources from 25 rural settlements in Brasov country which are shown in Fig.1.

According to the laws in force, the quality parameters of the analyzed drinking water are:

a) Microbiological parameters:
   - *Escherichia coli*/100 ml – admitted value 0;
   - *Enterococci* (fecal streptococci)/100 ml – admitted value 0;

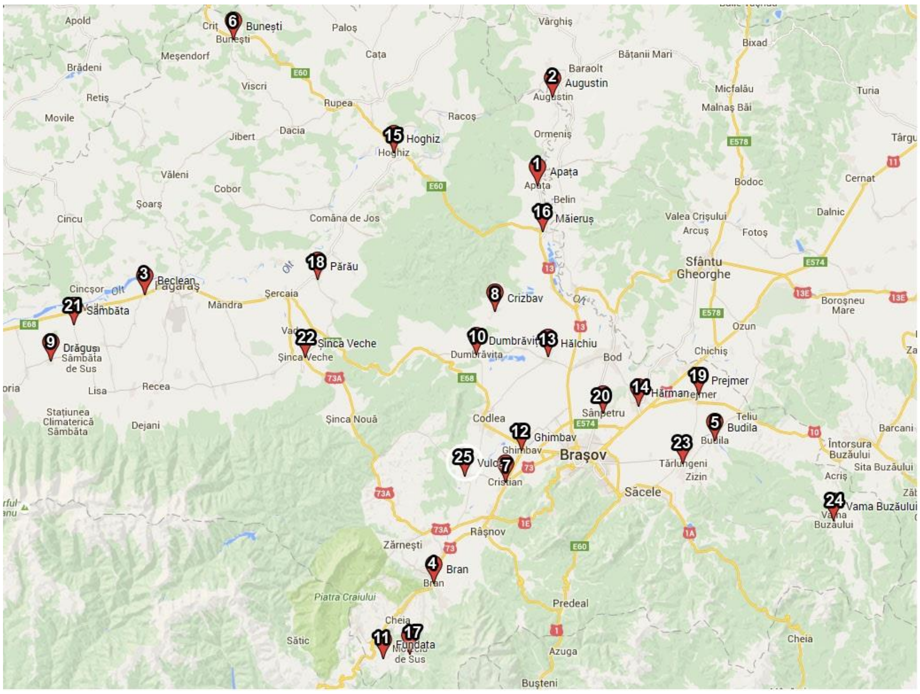
b) Indicator parameters:
   - *coliform* bacteria (number / 100 ml) – admitted value 0;
   - number of colonies at 22°C/ml – no abnormal modification/ml;
   - number of colonies at 37°C/ml – no abnormal modification/ml;

c) Chemical parameters: nitrites, nitrates, total conductivity, degree Clark, oxidization, PH and turbidity [3].

The analysis of the chemical parameters from the studied samples revealed that all sources fall within the admitted values according to legal standards.

As for the microbiological parameters and indicators analysis from the total number of water sources 123 (62 %) are non-compliant to drinkability standards.

The analysis of the water samples we took from the 25 settlements (villages, towns) in Brasov county revealed that the water was potable, despite the fact that certain parameters did not meet local regulatory criteria.



Map legend

Town	No. on map
Apata	1
Augustin	2
Beclean	3
Bran	4
Budila	5
Bunesti	6
Cristian	7
Crizbav	8
Dragus	9
Dumbravita	10
Fundata	11
Ghimbav	12
Halchiu	13
Harman	14
Hoghiz	15
Maierus	16
Moeciu	17
Parau	18
Prejmer	19
Sanpetru	20
Simbata	21
Sinca	22
Tarlungeni	23
Vama Buzaului	24
Vulcan	25

Fig. 1. Map of selected settlements for our studyin Brasov County

The highest number of non-compliant samples were recorded in *coliform* bacteria tests – 71 samples (36%) (Fig. 2).

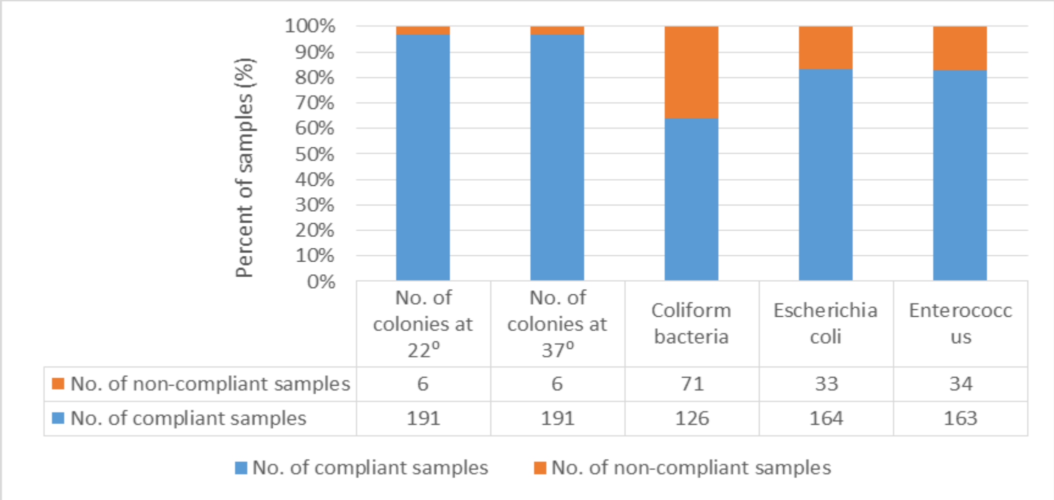


Fig. 2. Sample analysis according to microbiological parameters

Escherichia coli and *Enterococcus* contamination were investigated. They occurred in about 16-17% of all samples. Regarding the number of colonies present at 22^0 and 37^0 respectively, only three localities provided us with non-compliant samples: one locality had two non-compliant samples out of a total of eight (25%), another locality had one non-compliant sample out of six (16.67%), and the third locality had three non-compliant samples out of 21 (14.29%).

The samples are non-compliant due to the alteration of one or more parameters. According to this criterion the repartition of non-compliant samples was: 43% of samples showed the presence of one germ category; 33% of samples showed the presence of two germ categories and 24% of samples showed the presence of three germ categories.

No *Enterococcus spp.* contamination was noticed in samples from 7 localities (Bran Dragus, Beclean, Ghimbav, Halchiu, Hoghiz, Prejmer, Simpetru and Tarlungeni). In samplestaken from other 13 localities, less than 40% of sampled showed the presence of such cocci. Only three localities were reported to have more than half of the total number of samples contaminated with *Enterococcus spp*. (Fig. 3).

With respect to the presence of *coliform* bacteria, seven settlements (Vama Buzaului, Ghimbav, Halchiu, Hoghiz, Prejmer, Sanpetru and Tarlungeni) showed no contamination. Less than 34% of samples were contaminated with *coliform* bacteria in each of another 10 villages, samples from four settlements were contaminated in 50 to 62% of cases, and the rest of the settlements (four) provided non-compliant samples in more than 83% of cases (Fig. 4).

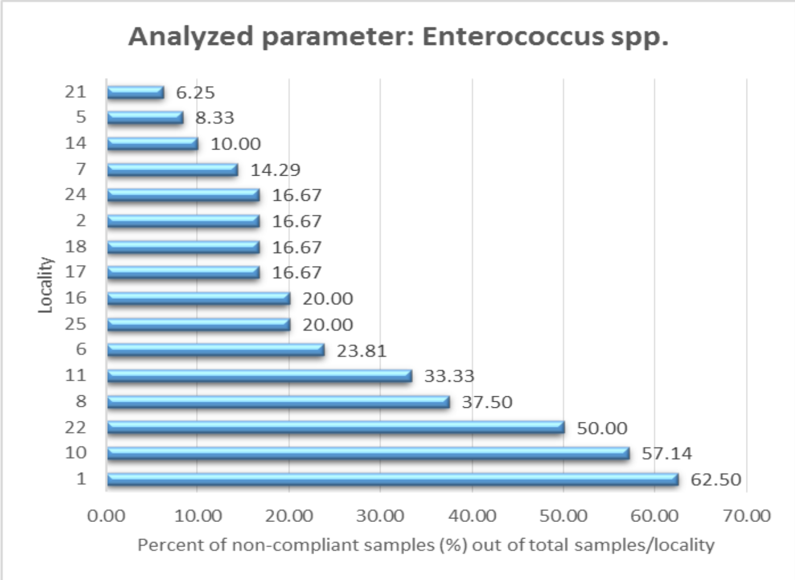


Fig. 3. Samples showing contamination with *Enterococcus spp*

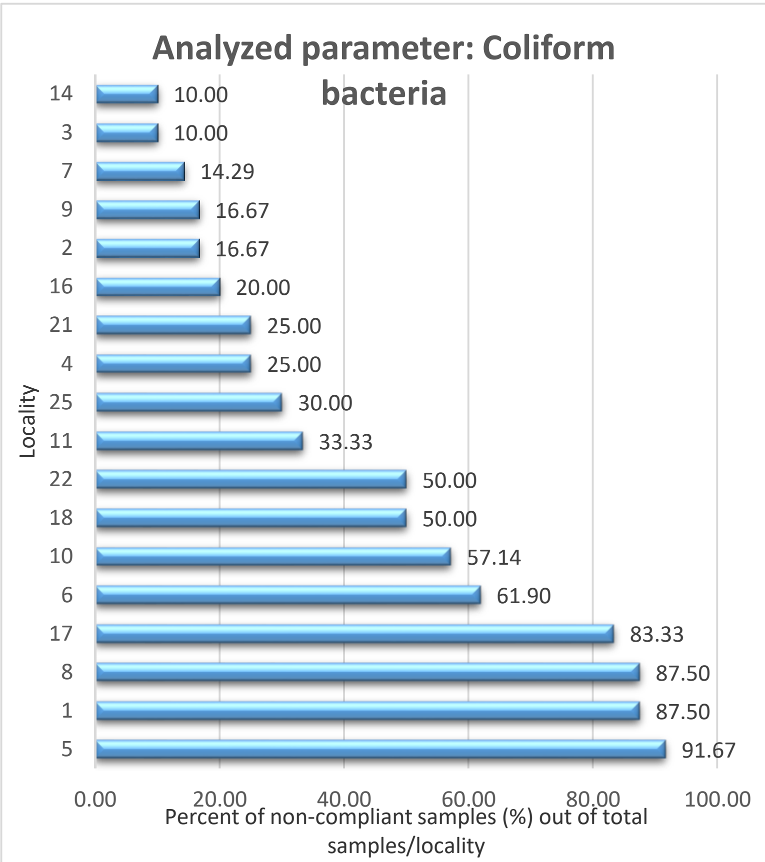


Fig. 4. Samples showing contamination with *coliform* bacteria

The same seven settlements as mentioned above did not provide any non-compliant samples in our assay of *Escherichia coli*. (Vama Buzaului, Ghimbav, Halchiu, Hoghiz, Prejmer, Sanpetru and Tarlungeni). The samples collected from all the other towns were contaminated in 50% or less of the cases (Fig. 5).

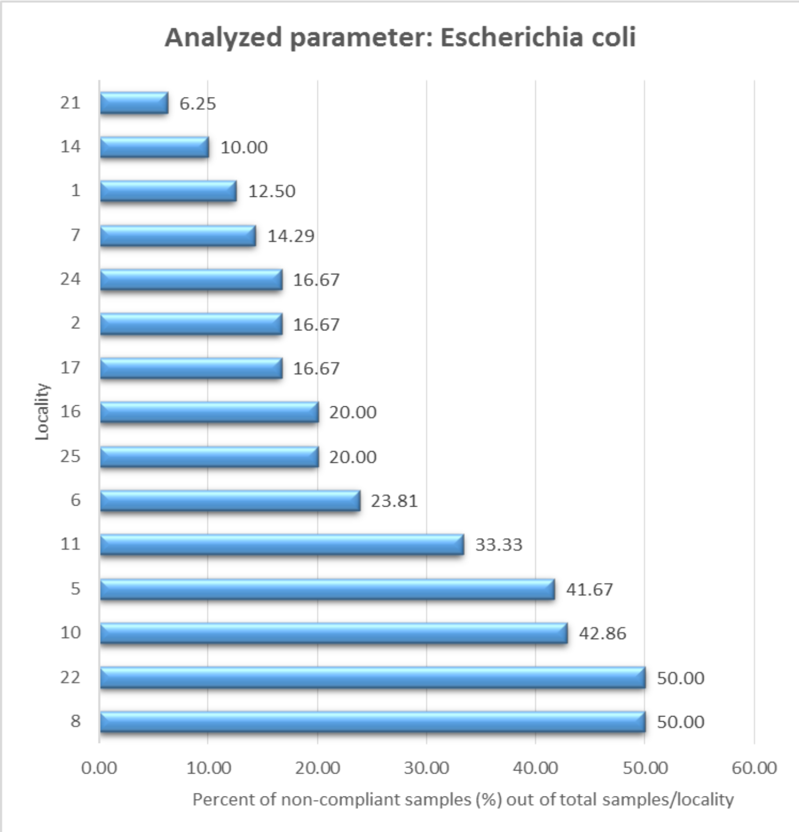


Fig. 5. Samples showing contamination with *E. coli*

In 2012, a number of 1,9 million people used either an improper water source or a source with fecal contamination. The greatest danger to public health is associated with the ingestion of animal or human feces contaminated water [13].

Our study aimed to assess the presence of certain relevant microorganisms in water samples collected from different water sources across a centralized water supply system in Brasov county. However, we wish to further investigate the possible causes that have led to the contamination of some of the water sources in order to identify appropriate means for the prevention and control of such events.

The water contamination occurred mainly due to the particular locations of the water sources. Situated in a rural environment, these sources are surrounded by fields where domestic animals such as cattle are frequently free at grass.

Animal feces thus infiltrate the water table, and in some cases water is collected from sources that are not located at a proper depth. There are no other factors that could explain the contamination: the *coliform* bacteria and *Enterococci spp.* found in our samples are most likely to have an animal source, but more research is needed.

As such, sanitary inspections of water sources and their surroundings are extremely necessary in order to ensure the safety of drinking water, together with a good preventative risk management and a thorough identification of hazards [14,15].

International monitoring of status and trends in drinking water and sanitation is provided by WHO and UNICEF through their 'joint monitoring program' (JMP) [16] — Itself a continuation of monitoring initiated in the 1960's [17, 18].

4. Conclusions:

The analysis of drinkable water samples supplied by a centralized water system in Brasov country from rural areas has shown the causes which may could lead to the lack of fulfillment of the drinkability parameters. These are of technical, financial and human nature. There is insufficient protection and surveillance in the caption of water sources.

We observed a lack of disinfection or inappropriate disinfection of potable water and disinfection without the monitoring of residual chlorine. Also, there is no evidence regarding the cleaning and disinfection of drinking water storage pools, and there are interruptions in the process of acquiring disinfectant substances. Furthermore, there is no verifying of the efficiency of the disinfection process. The study has shown that the water from surface sources treatment does not cover all the necessary steps, usually missing the phases of sedimentation and coagulation to which is added the lack of the registry of utilized substances.

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